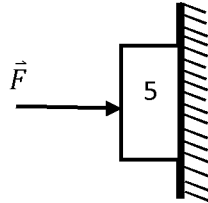
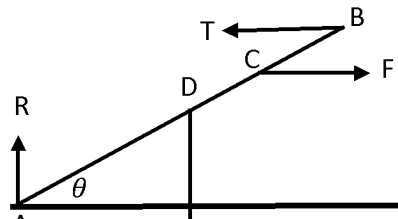


First: Answer the following question (mandatory):**First question: complete the following statements to be correct:**

- 1) Two couples are equivalent if
- 2) If θ is the measure of the angle included between the two vectors \vec{A} , \vec{B} and $|| \vec{A} \times \vec{B} || = \vec{A} \odot \vec{B}$, then $\theta = \dots\dots\dots$
- 3) Two parallel forces whose magnitudes are F , 15 newton act at two points A and B respectively where their resultant equals 10 newton and acts in the same direction of the force \vec{F} . then $F = \dots\dots\dots$
- 4) The magnitude of the smallest horizontal force that makes a body of mass 5 kg. in equilibrium on a vertical rough wall where the coefficient of friction between them equals $\frac{1}{3}$ equalskg. wt. 
- 5) If \vec{f}_1 and \vec{f}_2 are two parallel forces such that: $\vec{f}_1 = (1, m)$ and $\vec{f}_2 = (m^2, -8)$ then the algebraic components of \vec{f}_1 in direction of \vec{f}_2 equals
- 6) In the opposite figure : AB is a uniform rod whose weight is 12 newton , $\sin \theta = \frac{3}{5}$ C is the midpoint of \overline{BD} .If the rod is equilibrium under the effect of two couples. then: $F + T + R = \dots\dots\dots$ 

Second: Answer three of the following questions:**Second question:**

- a) A body whose weight is W newton is placed on a rough plane inclined at angle of measure θ to the horizontal and the measure of the angle of friction is λ . Where $\theta > \lambda$. A force acts on the body in the direction of the line of the greatest slope to prevent the body from slipping. Prove that the least magnitude of the force is $\frac{\sin(\theta - \lambda)}{\cos \lambda} W$
- b) The force $\vec{f} = 2\vec{i} + 1.5\vec{j}$ acts at the point A (5, -1) .Calculate the moment of the force \vec{f} about the points B(2 , 3) , D(-2 , 0) ,then show that the line of action of the force \vec{f} is parallel to \overline{BD}

Third question:

- a) Three forces equal in magnitudes act at the vertices of a triangle in the same direction prove that the resultant of these forces acts at the intersection point of the medians of the triangle .
- b) A uniform ladder AB of weight W and length L rests in a vertical plane with its end A against a smooth vertical wall and with its end B on a rough horizontal floor . The coefficient of friction between the ladder and the floor equals $\frac{4}{3}$. If the ladder inclined to the horizontal by an angle of measure θ where $\tan \theta = \frac{1}{2}$. Find the furthest point from B on the ladder in which a weight twice the weight of the ladder will be hanged and the ladder still in equilibrium.

Fourth question:

- a) AB is a uniform rod of weight 20 newton and length 50 cm can rotate easily in a vertical plane around a hinge fixed at A , A couple of magnitude 250 newton.cm and whose direction is perpendicular to the plane of the rod acts on the rod . Find in the position of equilibrium the magnitude and the direction of the reaction of the hinge and the inclination of the rod to the horizontal.
- b) In ΔABC , $M \in \overline{AB}$ such that $AM : MB = 1 : 2$, , $N \in \overline{AC}$ such that $AN : NC = 2 : 1$ IF $\overrightarrow{AN} \times \overrightarrow{MN} = \overrightarrow{AC} \times K \overrightarrow{BC}$ where $k > 0$, find the value of the constant K

Fifth question:

- a) AD is a non-uniform rod rests horizontally on two smooth supports B , C such that : $AB = BC = CD$, If a weight of 5 kg. wt. is suspended from A or if a weight of 10 kg. wt. is suspended from D the rod is about to rotate . Find the weight of the rod and prove that the point of application of weight divides the rod at ratio 4 : 5 form from A.
- b) ABC is a right angled triangle at B , $AB = 3$ cm , $BC = 4$ cm , forces of magnitudes 12 , 16 , 20 newton act on the directions \overrightarrow{AB} , \overrightarrow{BC} , \overrightarrow{CA} respectively , prove that the system equivalent to a couple then find the magnitude of its moment also find the magnitude of the two forces act at A and C perpendicular to \overrightarrow{AC} to equilibrium with the given forces .